What is claimed is:

1. In a plasma reactor for processing a semiconductor wafer, the reactor having a wafer processing chamber containing a wafer support pedestal and having at least one RF power applicator capable of coupling RF power into the chamber and a vacuum pump coupled to a pumping port of the chamber, the reactor tending to accumulate on its interior surfaces a residue formed from process gases introduced into the wafer processing chamber, a method for removing said residue from said interior surfaces comprising the steps of:

ionizing a gas compound of an electro-negative etch species in a secondary plasma chamber to produce an atomically free form of said etch species;

passing from said secondary chamber into said wafer processing chamber at least one of: (a) said atomically free form of said etch species, and (b) molecules of said etch species formed by recombination of said atomically free form of said etch species;

producing free electrons in said wafer processing chamber so as to convert said molecules of said etch species into ions of said etch species by electron attachment.

2. The method of Claim 1 wherein the step of producing free electrons in said wafer processing chamber comprises introducing into said wafer processing chamber an electron donor gas and ionizing said electron donor gas by coupling of RF power into said wafer processing chamber by at least the one RF power applicator.

3. The method of Claim 2 wherein the step of ionizing said electron donor gas produces at least nearly an order of magnitude less ionization energy than the step of ionizing said gas compound of the etch species.

4. The method of Claim 3 wherein said electro-negative etch species comprises a member of the halogen chemical group and said electron donor gas comprises one of the inert gases.

5. The method of Claim 4 wherein said member of the halogen group comprise fluorine.

6. The method of Claim 4 wherein said one inert gas comprises helium.

7. The method of Claim 1 wherein the step of passing comprises maintaining said secondary chamber next to said wafer processing chamber and passing said etch species through a single passageway between the chambers so as to minimize loss of said atomically free form of said etch species by recombination.

8. The method of Claim 1 wherein the step of passing comprises feeding said etch species from said secondary chamber through at least one injection element facing into said wafer processing chamber.

9. The method of Claim 8 further comprising feeding said etch species to said plural injection elements through a gas manifold.

10. The method of Claim 9 further comprising feeding said etch species through an elongate feed tube connected between said secondary chamber and said wafer processing chamber while maintaining said secondary chamber and said primary chamber at a separation distance corresponding to said elongate feed tube.

11. The method of Claim 10 wherein at least most or all of the free atomic form of said etch species recombines into molecules of said etch species prior to injection into said wafer processing chamber.

12. The method of Claim 1 wherein the step of feeding said etch species through plural injection elements causes said etch species to be injected into said chamber in a direction away from said vacuum pumping port, whereby to increase residency time of said etch species in said wafer processing chamber.

13. The method of Claim 1 wherein the step of passing comprises injecting said etch species into said wafer processing chamber in a direction away from said pumping port.

14. The method of Claim 13 wherein the step of injecting comprises injecting said etch species in a direction generally parallel to and adjacent an interior surface of said chamber.

15. The method of Claim 14 wherein said interior surface is a side wall of said wafer processing chamber and said pumping port is near a floor of the wafer processing chamber, and wherein the step of injecting comprises injecting the etch species at entry points next to said side wall and in a direction away from said floor and toward said ceiling.

16. The method of Claim 15 wherein the step of injecting comprises injecting said etch species near the floor and in a direction away from the floor.

17. The method of Claim 1 wherein the step of passing comprises injecting the etch species into the wafer processing chamber near the pumping port and in a direction away from the pumping port.

18. The method of Claim 2 wherein said chamber further comprises plural RF power applicators comprising electrodes and coil antennas comprised within or adjacent walls of said chamber,

and wherein the step of coupling RF power into the wafer processing chamber comprises connecting at least one of said RF power applicators to an RF power source and connecting others of said RF power applicators to an RF return potential.

19. The method of Claim 18 further comprising connecting further ones of said RF power applicators to a floating potential.

20. A method of cleaning interior surfaces of a wafer processing chamber comprising the steps of:

ionizing in a secondary plasma chamber a stable gas compound of an electronegative etch species to produce plasma products, said plasma products including molecules of said etch species formed by recombination of ions of said etch species;

supplying said plasma products into said wafer processing chamber;

ionizing by electron attachment in said wafer processing chamber the molecules of said electronegative etch species by introducing an electron donor gas into said wafer processing chamber and ionizing said electron donor gas to produce free electrons.

21. The method of Claim 20 wherein said etch species comprises a halogen element.

22. The method of Claim 21 wherein said stable gas compound comprises a compound of said halogen element and a non-metal element.

23. The method of Claim 21 wherein said stable gas compound comprises NF3.

24. The method of Claim 21 wherein said electron donor gas comprises an inert gas.

25. The method of Claim 24 wherein said inert gas comprises helium.

26. The method of Claim 20 wherein the step of supplying said plasma products into said wafer processing chamber comprises introducing said plasma products through a single port between said secondary chamber and said wafer processing chamber.

27. The method of Claim 20 wherein the step of supplying said plasma products into said wafer processing chamber comprises initially confining said products to an annular zone contiguous with a side wall of said chamber.

28. The method of Claim 27 wherein the step of initially confining said products comprises channeling said products to at least one injection nozzle adjacent said side wall.

29. The method of Claim 20 wherein the step of supplying said plasma products into said wafer processing chamber comprises injecting said products into an annular zone contiguous with a side wall of said chamber in a direction parallel with said side wall.

30. The method of Claim 29 wherein the step of injecting said products comprises feeding said products to plural gas injection passages facing into said wafer processing chamber located within a thin annular zone contiguous with said side wall and pointing in a gas injection direction at least nearly parallel with said side wall.

31. The method of Claim 29 wherein said wafer processing chamber has a pumping port coupled to a vacuum pump corresponding to a gas evacuation direction toward said pumping port, and wherein said gas injection direction of the step of injecting is

generally opposite to said gas evacuation direction.

32. The method of Claim 31 wherein the step of injecting said products comprises feeding said products to plural gas injection passages facing into said wafer processing chamber located within a thin annular zone contiguous with said side wall and pointing in a gas injection direction at least nearly parallel with said side wall and generally opposite to said gas evacuation direction.

33. In a wafer processing chamber tending to accumulate contaminant deposits on its interior surfaces during wafer processing, a method of removing said deposits comprising the steps of:

furnishing into said chamber products produced in an external source by ionizing a stable gas compound of an electronegative etch species;

ionizing molecules of said electronegative etch species by electron attachment in said plasma processing chamber.

34. The method of Claim 33 wherein the step of ionizing said molecules of said electronegative etch species comprises introducing an electron donor gas into said wafer processing chamber and ionizing said electron donor gas to produce free electrons.

35. The method of Claim 33 wherein said etch species comprises a halogen element.

36. The method of Claim 21 wherein said stable gas compound comprises a compound of said halogen element and a non-metal element.

37. The method of Claim 34 wherein said electron donor gas comprises an inert gas.

38. The method of Claim 33 wherein the step of furnishing the products into said wafer processing chamber comprises introducing said products through a single port between said external source and said wafer processing chamber.

39. The method of Claim 33 wherein the step of furnishing said products into said wafer processing chamber comprises initially confining said products to an annular zone contiguous with a side wall of said chamber.

40. The method of Claim 39 wherein the step of initially confining said products comprises channeling said products to plural injection nozzles adjacent said side wall.

41. The method of Claim 33 wherein the step of furnishing said plasma products into said wafer processing chamber comprises injecting said products into an annular zone contiguous with a side wall of said chamber in a direction parallel with said side wall.

42. The method of Claim 41 wherein the step of injecting said products comprises feeding said products to plural gas injection passages facing into said wafer processing chamber located within a thin annular zone contiguous with said side wall and pointing in a gas injection direction at least nearly parallel with said side wall.

43. The method of Claim 42 wherein said wafer processing chamber has a pumping port coupled to a vacuum pump corresponding to a gas evacuation direction toward said pumping port, and wherein said gas injection direction of the step of injecting is generally opposite to said gas evacuation direction.

44. The method of Claim 43 wherein the step of injecting said products comprises feeding said products to plural gas injection passages facing into said wafer processing chamber located within a thin annular zone contiguous with said side wall and pointing in a gas injection direction at least nearly parallel with said side wall and generally opposite to said gas evacuation direction.

45. The method of Claim 34 wherein the step of introducing an electron donor gas comprises injecting said electron donor gas through gas passages in a wafer support pedestal of said wafer processing chamber.

46. The method of Claim 34 wherein the step of introducing an electron donor gas comprises injecting said electron donor gas through gas injection elements facing into said wafer processing chamber.

47. The method of Claim 33 wherein the step of furnishing the products into the wafer processing chamber comprises furnishing primarily molecules of said etch species formed by recombination of ions of said etch species.

48. The method of Claim 33 wherein the step of ionizing said electron donor gas comprises applying an amount of RF power that is insufficient to achieve a kinetic ionization of said gas molecules of said etch species.

49. The method of Claim 48 wherein the step of ionizing said electron donor gas comprises applying an amount of RF power that is several time less than that required to ionize said gas compound of said electronegative etch species.

50. The method of Claim 34 wherein said wafer processing chamber comprises RF power applicator apparatus and wherein the

step of ionizing an electron donor gas comprises applying RF power to said RF power applicator apparatus.

51. The method of Claim 50 wherein said RF power applicator apparatus comprises plural RF power applicators at respect locations about said wafer processing chamber, and wherein the step of ionizing an electron donor gas comprises enhancing concentration of ions of said etch species near a selected area of an enclosure wall of said wafer processing chamber by applying RF power across two of said RF power applicators while permitting others of said RF power applicators to float electrically, one of said two RF power applicators being adjacent said selected area.

52. A plasma reactor for processing a semiconductor wafer, comprising:

a wafer processing chamber having a wafer support pedestal therein and enclosed by at least a side wall;

a cleaning gas ionizing chamber;

gas injection apparatus having at least one gas outlet facing into a zone of said wafer processing chamber that is confined to a thin annulus contiguous with said side wall and in a gas injection direction that is generally parallel to said side wall;

a gas manifold connected to said cleaning gas ionization chamber and to gas input ends of said plural gas injection elements;

gas inlet elements facing into said wafer processing chamber for supplying an electron donor gas; and

RF power applicator apparatus for ionizing said electron donor gas.

53. The plasma reactor of Claim 52 further comprising a pumping port in said wafer processing chamber and a vacuum source coupled to said pumping port, wherein gas evacuation flow in said wafer processing chamber is in an evacuation direction toward said

pumping port, said gas injection direction being generally opposite to said gas evacuation direction.

54. The plasma reactor of Claim 52 wherein said RF power applicator apparatus comprises:

an RF power generator connectable to said wafer support pedestal;

a coil antenna alternately connectable to ground and to an RF power source;

an RF power generator connectable alternately to said side wall.

55. The plasma reactor of Claim 52 wherein said RF power applicator apparatus comprises:

plural RF power applicators located at respective locations about said wafer processing chamber; and

plural switches connected respectively to said plural RF power applicators, each of said switches capable of switching the corresponding RF power applicator to an RF power source, RF ground and a floating potential.

56. The plasma reactor of Claim 55 wherein said plural RF power applicators comprise:

said wafer pedestal;

a wall of said wafer processing chamber;

a coil antenna.

57. The plasma reactor of Claim 56 wherein said wall of said wafer processing chamber is a side wall and said coil antenna is a cylindrical coil antenna wound around said side wall, said plural RF power applicators further comprising:

a ceiling of said wafer processing chamber;

a coil antenna overlying said ceiling.

58. The plasma reactor of Claim 52 wherein said gas injection apparatus comprises plural discrete gas injection nozzles.

59. The gas injection apparatus of Claim 52 wherein said gas injection apparatus comprises a circumferential gap nozzle.